Appendix A: Gulf of Maine, Fisheries, and Protected Species

Characterization of the Gulf of Maine RFI Area

A. Seafloor & Oceanographic Factors

The Gulf of Maine is a cold-water epicontinental sea partially enclosed from the Atlantic Ocean by Georges Bank and the Scotian Shelf. It is characterized by complex seafloor morphology and current patterns which in turn support rich biological productivity. The morphology of the Gulf was formed by multiple factors including fluvial and glacial erosion and the deposition of material through glacial processes.[1]

The State of Maine occupies over 5,600 km (3,500 miles) of tidally-influenced shoreline of the Gulf of Maine, the longest portion of coastline of the U.S. portion of the Gulf. From tidal areas to 90 meters in depth is characterized as rocky with notable glacial and riverine deposits of sand and gravel (such as the Kennebec paleo-delta) as well as muddy and sediment deposits over large areas. The 90 meter (50 fathom) depth contour generally follows the 9 nautical mile distance from shore. The crystalline bedrock in this area has considerable relief and is unique in the Gulf in Maine as being generally exposed and having highly rugose structure when compared to hard-bottom structure areas off Massachusetts and New Hampshire.[2] Bedrock also often underlies coarse-grained glacial deposits that can either infill bedrock lows or rest upon bedrock high grounds and add additional relief. In some locations, post-glacial marine mud overlies the glacial deposits either in a draped form mimicking the deeper relief or in a flatter morphology from sediment infilling enclosed basins.[3] These muddy sediment deposits are the result of marine deposition during a post-glacial period when sea level was higher than present.[4]

Subsequent fall in sea level ~12,000 years ago resulted in the shoreline and coastal processes such as surf reworking some of the previous sediments. This led to winnowing of fine marine muds and sands leaving coarser glacial gravel and boulders on shoals. Flanks of shoals and ridges as well as basins received this finer sediment and added thickness to existing sedimentary layers. This burial with additional sediment resulted in smoothing of seafloor relief and is seen in wider spacing of bathymetric contours.[3] The low sea level resulted in subaerial exposure of the shallower portions of the inner continental shelf. Terrestrial sedimentary environments might be encountered at depths shallower than 60-70 meters below the present sea level, with the most likely concentration at the "slowstand" at 18-27 meters below present sea level, occurring ~11-8,000 years ago. Such settings might include fluvial deposits from ancestral rivers, lake deposits, freshwater wetlands, salt marshes, and paleosols.[4]

Beyond 9 nautical miles, multiple banks and higher relief features exist. Generally, the surfaces of these areas are composed of larger unconsolidated sediment and provide structure for

[1] Uchupi and Bolmer. 2008. Geologic evolution of the Gulf of Maine region. Earth-Science Reviews: 91 (1-4): 27-76.
[2] Gulf of Maine Seascapes Map Product. 2022. Northeast Regional Ocean Council's Habitat and Ocean Mapping Subcommittee.
[3] Kelley et al. 2005. The Seafloor Revealed: The Geology of the Northwestern Gulf of Maine Inner Continental Shelf. Maine Geological Survey Open-File 96-6. https://www.maine.gov/dacf/mgs/explore/marine/seafloor/contents.htm
[4] Kelley, J.T., Belknap, D.F., Kelley, A.R. and Claesson, S.H., 2013, A model for drowned terrestrial habitats with associated archeological remains in the northwestern Gulf of Maine, USA: Marine Geology, v. 338, p. 1-16. http://dx.doi.org/10.1016/j.margeo.2012.10.016

epifauna and multiple fish assemblages.[5,6] These areas, generally well described in the literature, include features extending from ~20-28 nautical miles off Massachusetts to Penobscot Bay (Stellwagen Bank[7], Jeffreys Ledge[8], Platts Bank[5], Jeffreys Bank[9], a large moraine spanning from the north end of Jeffreys ledge to the southeast corner of Jeffreys Bank), and Mount Desert Rock, an area of hard and complex substrate abruptly rising to the surface from over 90 meters that supports cold water coral assemblages and complex above and below water trophic interactions[10]. Farther offshore, Fippennies Ledge[11,12] and Cashes Ledge[13,14] form bathymetric highs and important hard complex structure for benthic communities. In addition to the structure and complex benthic habitat that all these areas provide, they serve as important upwelling zones[15] due to multiple factors including a quick rise in bathymetry from the deep basins within the Gulf where warm, salty water that has entered the Gulf of Maine through primarily the Northeast Channel.[16] While many of these features have been well described, the lack of high-resolution bathymetry data in the majority of the Gulf of Maine[17] leaves the many features virtually unknown except for general accounts in fisheries accounts.[9]

A less described feature that has been recently mapped with multi-beam echosounder surveys and exposed as a unique and continuous feature rather than a series of disjointed fishing grounds[18] is a glacial moraine extending from Jeffreys Ledge to Jeffreys Bank approximately following the Maine coastline 15-20nm offshore. This moraine was likely formed as a glacial grounding line of the Laurentide Ice Sheet where the base of the glacier had direct contact with the bedrock to the north or landward, "up ice" direction, and where thinner ice and deeper water resulted in a floating ice shelf and ice bergs calving into the open water of the Gulf of Maine. The grounding line position resulted in sediment deposited directly seaward in the form of submarine fans and farther out into the Gulf of Maine as a poorly sorted mix of boulders (drop stones) gravel, sand, and mud that melted out of glacial ice. Ice melt and glacial thinning during deglaciation led to additional deposition of till, eskers, moraines, and other glacial features across the seafloor landward of the moraine.[19]

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[5] Stevick et al. 2008. Trophic relationships and oceanography on and around a small offshore bank. Marine Ecology Progress Series. 363: 15-28. doi: 10.3354/meps07475

[6] Goode et al. 2021. Evaluating benthic impact of the Gulf of Maine lobster fishery using the Swept Area Seabed Impact (SASI) model. Canadian Journal of Fisheries and Aquatic Sciences. https://doi.org/10.1139/cjfas-2020-030

[7] Valentine and Schmuck.1994. Geological mapping of biological habitats on Georges Bank and Stellwagen Bank, Gulf of Maine region." *Proc. 8th Western Groundfish Conference, Nanaimo, Brit. Col.*

[8] http://ccom.unh.edu/project/jeffreys-ledge

[9] Rich. 1929. Fishing Grounds of the Gulf of Maine. Bureau of Fisheries Document No. 1059.

[10] Rajakaruna et al. 2009. Ornithocoprophilous plants of Mount Desert Rock, a remote bird-nesting island in the Gulf of Maine, USA. Rhodora 111.948: 417-447.

[11] Schlee, and Cheetham. 1967. Rocks of Eocene age on Fippennies Ledge, Gulf of Maine." Geological Society of America Bulletin 78.5: 681-684.

[12] Asci et al. 2018. Estimating similarity in benthic communities over decades and in areas open and closed to fishing in the central Gulf of Maine, USA. Marine Ecology Progress Series 595: 15-26.

[13] Uchupi. 1966. Topography and structure of Cashes ledge, Gulf of Maine. Atlantic Geology, 2(3): 117-120.

[14] Calvert and McGonigle. 2020. Benthic community structure at a remote temperate rocky reef in the Gulf of Maine, Cashes Ledge. In Seafloor Geomorphology as Benthic Habitat. Elsevier: 461-471.

[15] Weinrich et al. 1997. A shift in distribution of humpback whales, Megaptera novaeangliae, in response to prey in the southern Gulf of Maine. Fishery Bulletin 95: 826-836

[16] Brooks. 1985. Vernal circulation in the Gulf of Maine. Journal of Geophysical Research: Oceans, 90(C3): 4687-4706.

[17] https://www.ncei.noaa.gov/maps/bathymetry/

[18] https://dmr-maine.opendata.arcgis.com/datasets/mainedmr-fishing-grounds-of-the-gom-polygon-p/explore?location=43.310462%2C-69.102241%2C8.32

[19] Personal communication, Stephen M. Dickson, Ph.D., Marine Geologist and Maine State Geologist, Maine Geological Survey. August, 2022.

Within the Gulf of Maine are three major basins, Wilkinson, Jordan, and Georges. Comparatively warmer, denser, and saltier water from the Atlantic Ocean enters the Gulf of Maine through the Northeast Channel and enters these basins[20], each of which exceed 250 meters in depth though all are separated from each other by relative bathymetric highs in the central Gulf of 90-150 meters. Wilkinson Basin consists of Holocene clays and silty clays with slight coarsening in the upper meter due to substantial infauna colonization resulting in bioturbation.[21] The sediments are horizontally and laterally heterogeneous.[22] Within Jordan Basin, sediments containing the remains of pelagic organisms are 25 meters thick, with underlying deglacial sediments that indicate ice-free conditions began 16,900 years before present. The basin floor sediments (270-290 meters) accumulated at >3 meters per thousand years during the Holocene, however the accumulation rate was significantly less on the Basin's slopes.[23] Georges Basin, the largest basin in the Gulf, is connected to the Northeast Channel and is the primary exchange of deep waters between the Gulf and the continental slope.[20] Each of these basins play important roles in the circulation of water and nutrients within the Gulf. The circulation of this deep water is influenced by the Coriolis effect, replacing more of the bottom water in Jordan Basin than in Wilkinson Basin.[20] At depth within Wilkinson and Jordan Basins, circulation may be clockwise.[24,25] Because Wilkinson Basin is partly isolated by the bathymetric highs of Jeffreys Bank, it has minimal and closed circulation while providing the majority of outflow from the inner and eastern Gulf of Maine toward the Great South Channel and Georges Bank.[26]

Circulation patterns within the Gulf of Maine are highly dynamic and seasonal and are showing evidence of rapid change due to regional and climatic changes in water temperature and salinity.[27] Surface circulation in the Gulf of Maine is primarily counterclockwise, dominated by the Gulf of Maine Coastal Current hat brings cold water into the Gulf from the Labrador current. The current splits into two currents: the Eastern Maine Coastal Current that continues along the coast until it bends offshore at Penobscot Bay due to both the influx of a large amount of freshwater discharge from the Penobscot River and deep water circulation patterns. Part of this circulation bends off the coast and partially submerges into Jordan Basin while the remainder continues southwestern along the coast as the Western Maine Coastal Current until it turns back towards the inner Gulf off Massachusetts Bay.[28] Circulation in the Gulf of Maine varies seasonally, where three stratified layers are found in the summer: a thin surface layer of

[20] Townsend. 1991. Influences of Oceanographic Processes on the Biological Productivity of the Gulf of Maine. Reviews in Aquatic Sciences 5(3-4): 211-230.
[21] Faas and Nittrouer. 1976. Postdepositional facies development in the fine-grained sediments of the Wilkinson Basin, Gulf of Maine. Journal of Sedimentary Research 46(2): 337-344.
[22] Richards and Perlow. 1972. Variability of Geotechnical Properties of Lutite in Wilkinson Basin, Gulf of Maine, as Measured in Place from Submersible Alvin. AAPG Bulletin, 56(3): 647-648.
[23] Keigwin and Pilskaln. 2015. Sediment flux and recent paleoclimate in JordanBasin, Gulf of Maine. Continental Shelf Research, 96: 45-55.
[24] Butman and Beardsley. 1987. Long-term observations on the southern flank of Georges Bank. Part I: A description of the seasonal cycle of currents, temperature, stratification, and wind stress. Journal of Physical Oceanography, 17(3): 367-384.
[25] Boucher et al. 2013. Effects of interannual environmental variability on the transport-retention dynamics in haddock Melanogrammus aeglefinus larvae on Georges Bank. Marine Ecology Progress Series, 487: 201-215.
[26] Brooks. 1992. A brief overview of the physical oceanography of the Gulf of Maine. In Proceedings of the Gulf of Maine scientific workshop. Urban Harbors Institute, University of Massachusetts, Boston. pp. 51-74.
[27] Balch, et al. 2022. Changing hydrographic, biogeochemical, and acidification properties in the Gulf of Maine as measured by the Gulf of Maine North Atlantic Time Series, GNATS, between 1998 and 2018. Journal of Geophysical Research: Biogeosciences, 127. https://doi.org/10.1029/2022JG006790
[28] Pettigrew, et al. 2005. The kinematic and hydrographic structure of the Gulf of Maine Coastal Current. Deep Sea Research Part II: Topical Studies in Oceanography 52(19-21): 2369-2391.

relatively warm and fresh water; the Maine Intermediate Water of saltier and colder water; and the warmer, denser, and saltier Maine Bottom Water which is found in all seasons.[29] During winter months, this stratification weakens as interior flow weakens and cooling of surface waters leads to sinking and convection to at least mid-depths in the three major basins.[30] As climatic forcing changes the basic chemistry of the oceans, the circulation patterns that feed the Gulf of Maine are changing, thus producing changes in the historically described complex patterns within the Gulf. Long term time-series measured by the Gulf of Maine North Atlantic Time Series (GNATS) between 1998 and 2018 found that after 2008 warm water intrusions, likely originating from North Atlantic Slope Water, were observed in the eastern Gulf at depths of 50-180 meters, while shallow waters (<50 m) significantly warmed in winter, summer, and fall. The time series also documented that surface salinity and density also significantly increased over the period of 1998-2018. These changes led to cascading changes in phytoplankton standing stock, phosphate, residual nitrate, and dissolved organic carbon. [27]

B. Marine Mammals/Protected Species/Highly Migratory Species

Numerous marine mammal and sea turtle species are found within the Gulf of Maine. Four species of sea turtles have been documented within the GOM: Leatherback (*Dermochelys coriacea*), Loggerhead (*Caretta caretta*), Kemp's Ridley (*Lepidochelys kempii*), and Green (*Cheloria mydas*). Historically, given the low water temperatures within the northern GOM in the winter months, these species have not been common year-round inhabitants and only leatherback and loggerhead sea turtles are observed within this portion of the GOM with any regularity. Further to the south in Cape Cod Bay, sea turtle sightings and strandings associated with cold stunned animals for more common. Leatherbacks are the most common species recorded through voluntary sightings reports and strandings data. Sea turtles utilize the GOM as foraging grounds and are generally considered migrants through the area likely foraging on resident seagrass, kelp beds, and jellyfish[31,32]. The regularity of sea turtle occurrence in the Gulf of Maine could increase in the future with shifts in ocean temperature and species assemblages.

Smaller cetaceans, such as large and small delphinids, are present within the Gulf of Maine and are likely to follow patterns of high productivity areas as they target schooling fish and squid species as their primary prey source. Harbor porpoises are common in the nearshore waters off Maine and larger species, such as Atlantic white-sided dolphins and pilot whales occur farther from shore. Large baleen whales, including humpback, minke, and the endangered fin, sei, and North Atlantic right whales, are distributed throughout the Gulf of Maine. Abundance densities of baleen whales have been derived using Duke University's MDAT models, which aggregate all the standardized data sources for sightings of these species in the region. Abundance of these species tends to be higher near significant features like Stellwagen Bank, Jeffreys Ledge, Platts

[29] Hopkins and Garfield. 1979. Gulf of Maine intermediate water. J. Mar. Res. 37(1).
[30] Brown and Beardsley. 1978. Winter circulation in the western Gulf of Maine: Part 1. Cooling and water mass formation. Journal of Physical Oceanography, 8(2): 265-277.
[31] Gulf of Maine Council on the Marine Environment. 2010. The Gulf of Maine in Context, State of the Gulf of Maine Report. Accessed August 2022 at http://www.gulfofmaine.org/state-of-the-gulf/docs/the-gulf-of-maine-in-context.pdf
[32] OBIS-SEAMAP. 2020. OBIS-SEAMAP Dataset Web Portal. Accessed August 2022 at http://seamap.env.duke.edu/

Bank, Cashes Ledge, Schoodic Ridges, and Grand Manan Banks[33]. Peak use by humpback and fin whales occurs throughout the summer, while patterns around habitat use by right whales are more diffuse and in a period of flux.

Of particular note is the endangered North Atlantic right whale (NARW). Population estimates for NARW have decreased to under 350 individuals. Adult and juvenile NARW forage throughout the continental shelf and slope waters of the northeast, occurring in greatest densities in the central and western GOM from late fall to early spring. Historic habitat use documented for right whales includes foraging grounds in the Bay of Fundy and around the Scotian Shelf in the late summer and fall, although this use has decreased since 2010. The area around Jeffreys Ledge is considered an important foraging ground and may serve as a wintering area from approximately November to January. Based on decades of migration data and studies undertaken on North Atlantic right whales, adults and juveniles may be found foraging in the GOM in any month of the year, or overwintering from November through January; however, even during peak occurrence periods, most sightings are concentrated in the more offshore waters with the exception of Cape Cod Bay in the early spring. Critical habitat for this species has been defined as the entire Gulf of Maine up to a nearshore exemption line mostly inside of Maine state waters. This broad region was identified as right whale critical habitat due to the circulation patterns and existence of deep ocean basins within the Gulf of Maine that are drivers for the production and transport of the right whale's primary prey species, *Calanus finmarchicus*[34]. Deep basins, such as Wilkinson's and Jordan Basins, are important to late stage calanus copepods that overwinter here near the bottom. These basins provide the prey source for right whale either in dense layers within the basins themselves or as source areas that seed habitats downstream. Additionally, areas of high productivity around these deep basins have been identified as areas of higher marine mammal abundance, including Jeffreys Ledge, Jeffreys Bank and Outer Fall, and Platts Bank. Largely, the occurrence of right whales throughout the northern Gulf of Maine tends to be more diffuse than feeding aggregations that occur in other regions such as Cape Cod and Massachusetts Bays and south of Nantucket Island. Additionally, use of the Gulf and adjacent habitats, such as the Bay of Fundy, has been declining since 2010[35,36,37,38].

In addition, a seasonal closure restricting the use of vertical buoy lines to protect right whales has recently been implemented off the Maine coast within Lobster Management Area 1 for the months of October through January on an annual basis. This closure spans across Maine lobster

[33] Northeast Data Portal. https://www.northeastoceandata.org/ Accessed August 2022
[34] Endangered and Threatened Species; Critical Habitat for Endangered North Atlantic Right Whale, 81 Fed. Reg. 4837 (January 27, 2016).
[35] Ross, C.H., Pendleton, D.E., Tupper, B., Brickman, D., Zani, M.A., Mayo, C.A., Record, N.R. 2021. Projecting regions of North Atlantic right whale, *Eubalaena glacialis*, habitat suitability in the Gulf of Maine for the year 2050. Elementa:Science of the Anthropocene. 9(1):00058
[36] Davies, K., M. Brown, P. Hamilton, A. Knowlton, C. Taggart, and A. Vanderlaan. 2019. Variation in North Atlantic right whale Eubalaena glacialis occurrence in the Bay of Fundy, Canada, over three decades. Endangered Species Research 39:159-171

[37] Record, N., Runge, J. A., Pendleton, D. E., Balch, W. M., Davies, K. T. A., Pershing, A. J., Johnson, C. L., Stamieszkin, K., Ji, R., Feng, Z., Kraus, S. D., Kenney, R. D., Hudak, C. A., Mayo, C. A., Chen, C., Salisbury, J. E., and C. R. S. Thompson. 2019. Rapid Climate-Driven Circulation Changes Threaten Conservation of Endangered North Atlantic Right Whales. *Oceanography,* 32, 2: 162-169
[38] Davis, G. E., Baumgartner, M. F., Bonnell, J. M., Bell, J., Berchok, C., Thorton, J. B., Brault, S., Buchanan, G., Charif, R. A., Cholewiak, D., Clark, C. W., Cockeron, P., Delarue, J., Dudzinski, K., Hatch, L., Hildebrand, J., Hodge, L., Klinck, H., Kraus, S., Martin, B., Mellinger, D. K., Moors-Murhpy, H., Nieukirk, S., Nowacek, D. P., Parks, S., Read, A. J., Rice, A. N., Risch, D., Sirovic, A., Soldevilla, M., Stafford, K., Stanistreet, J. E., Summers, E., Todd, S., Warde, A., and S. M. Van Parijs. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (Eubalaena glacialis) from 2004 to 2014. Scientific Reports. 7:13460 (1-12).

zones C, D, and E. Designated marine protected areas and NARW seasonal management areas have been identified by NOAA Fisheries to protect marine mammals and other species. There are three existing seasonal management areas within the Gulf of Maine: the Great South Channel, Race Point, and Cape Cod Bay. Currently, vessel speed restriction within these seasonal management areas are in place for vessels over 65ft to reduce the potential for collision with NARW. However, NOAA Fisheries has proposed revisions to the vessel speed restrictions, and a proposed rule currently out for comment recommended revising some of these seasonal management areas and to include vessels over 35 feet within the restrictions.

Highly migratory species (HMS) should be given separate consideration as they will likely be impacted by different effects throughout their range such as changes to the physical environment at close range and changes to the soundscape at close and far ranges. Generally, HMS species such as Tuna broadly utilize habitat within the Gulf of Maine. Areas of shoals and complex bottom have been known to be targeted by hook and line as well as the harpoon fleet. These species can be influenced by oceanographic features such as temperature fronts, localized upwelling and prey density. Additionally, HMS maybe affected by multiple wind farms depending on their migratory patterns. There are gaps in our understanding of the migratory behavior of some of these species which should be addressed in order to accurately predict effects of OSW on HMS.

C. Existing Management Areas

There are several habitat management and groundfish closed areas, U.S. Coast Guard (USCG) restrictions, and U.S. Department of Defense (DOD) wind exclusion areas within the Gulf of Maine. There are five Habitat management areas (HMAs) sited in the Gulf of Maine: Eastern Maine, Jeffreys Bank, Ammen Rock, Cashes Ledge and Fippennies Ledge. The Western Gulf of Maine Closure (WGOM) area is considered an HMA, but also has additional designations. HMAs restrict fishing vessels that utilize mobile bottom-tending gear. Mobile bottom-tending gear refers to gear that comes in contact with the ocean bottom and is towed from a vessel which is then moved through the water during fishing in order to capture fish. Examples of mobile bottom-tending gear includes otter trawls, beam trawls, hydraulic and non-hydraulic dredges, and some seines**.** There are also groundfish closed areas in the Gulf of Maine and may either be year-round, seasonal, or gear restricted areas. These will be discussed further within later sections of this document.

D. Commercial Fisheries

Gulf of Maine Fisheries

During the period of 2017 to 2021 Maine ex-vessel value exceeded $3.3 Billion. Of this value, 81% can be attributed to species caught partially or fully in Federal Waters, and potentially impacted by the RFI. Lobster represents the dominant species by value (78%), with herring, scallop, groundfish, tuna and quahog, each accounting for ~1% of the total. Embedded within this largely single species footprint for Maine is a complex mixture of spatial fishing intensity across species and fishery management schemes.

Maine's fishing footprint within the Gulf of Maine represents a transition from inshore areas predominantly represented by lobstering activity to offshore areas with groundfish and herring fishing activity located in and around gravel banks, ledge outcroppings, and deep basins. From fishermen, the State has heard concerns that existing fisheries have developed ways to minimize conflict between fisheries and changes to these footprints will cause challenges.

Table 1. State of Maine landings for commercial fisheries between the period of 2017 and 2021. Species highlighted in yellow indicate fisheries that occur entirely or partially in Federal Waters. "Other species" indicate aggregated commercial landings for species that did not meet confidentiality standards for reporting.

Species	2017	2018	2019	2020	2021	Grand Total
lobster	438,976,767	490,596,367	493,003,762	412,487,339	730,596,022	2,565,660,257
other species	46,843,894	52,692,875	73,444,388	39,118,015	60,667,633	272,766,805
soft clam	13,195,062	12,921,624	18,282,370	15,941,362	25,220,600	85,561,018
elver	12,166,417	21,753,350	20,197,518	5,067,521	16,681,103	75,865,910
Atlantic herring	17,712,598	16,654,578	5,933,499	4,206,324	1,856,658	46,363,656
oysters	6,679,667	7,286,107	7,665,497	6,025,808	10,143,631	37,800,710
scallop	9,354,050	6,359,662	4,545,669	6,975,003	8,350,198	35,584,582
bloodworms	6,442,499	6,659,399	6,286,131	6,786,173	5,575,533	31,749,736
menhaden	3,230,476	4,445,032	6,855,802	7,093,687	9,537,660	31,162,657
urchins	6,104,971	6,208,072	5,835,917	3,865,214	2,896,155	24,910,328
groundfish	4,558,798	4,938,868	4,010,117	2,185,854	2,533,871	18,227,508
tuna	2,587,046	3,198,532	4,382,563	3,912,980	2,284,731	16,365,853
blue mussel	2,125,701	2,738,476	3,405,966	2,781,852	4,388,831	15,440,825
hard clam	1,744,193	2,657,025	3,757,608	2,644,125	3,238,245	14,041,196
sandworms	1,533,774	1,487,826	1,585,795	2,102,155	1,873,423	8,582,973
crab	1,783,173	2,167,802	1,463,788	1,016,253	1,919,174	8,350,190
seaweed	807,711	974,981	855,068	1,096,816	1,450,074	5,184,651
mahogany quahog	1,202,528	1,072,330	894,474	613,780	-	3,783,112
alewife	569,623	677,530	818,193	586,668	723,291	3,375,305
periwinkle	745,474	638,593	599,696	297,226	730,577	3,011,566
yellow eel	20,347	9,062	8,214	22,438	1,463	61,524
Grand Total	$ 578,384,769	$646,138,091	$ 663,832,033	$ 524,826,594	$ 890,668,872	$ 3,303,850,360

Lobster

For Maine, the dominant fishery in value, license and impact to coastal fishing communities in Lobster. The federal component of this fishery, with approximately 1250 LMA1 permit holders, is constrained to Federal Lobster Fishery Management Area 1 (LMA1), with an offshore boundary running parallel to and approximately 40 nautical miles from the Maine coast. Lobster fishing does occur at lower levels further offshore in LMA3, but more restrictive size limits in the State of Maine have resulted in the majority of this fishery originating from other New England states.

The spatial footprint of this important fishery is underrepresented in both state and federal data as compared to other fisheries. In Maine, approximately 10% of lobster license holders are selected to report on a daily basis. As lobster fishing activity is known to decrease as a function of distance from shore and with different seasons, offshore fishing can be poorly characterized. At best, lobster fishing activity can be described in large spatial bins relative to distance from shore (0-3, 3-12 and 12+ miles) and management zone (A-G running east to west).

The lobster fishery will generally target areas of high complexity (gravel, bedrock) and to a lesser degree, low complexity areas (sand, mud). Transitions between habitat types (edges) are favored. Lobster fishing is generally less than 600' in depth. However; regions in eastern Maine will fish in depths in excess of 600' at times of the year.

Lobster fishing avoids areas of conflict with mobile fishing gear. In areas where lobstering and mobile gear fisheries need to coexist, a series of formal and informal agreements seek to reduce conflict.

Groundfish

Maine groundfish activity transitions to higher intensity as lobster activity decreases. This is particularly evident in eastern Maine where groundfish activity is largely absent, only beginning south of the Schoodic Ridges and associated with Jordan Basin. In western Maine there is less of a clear delineation between fisheries closer to shore. Areas near Jeffreys Ledge and Platts Bank are important fishing grounds that have connectivity to deeper portions of the Gulf of Maine, particularly Wilkinson Basin.

Recent trends in groundfish activity indicate a decline in the value, participation and the number of directly impacted communities. However; groundfishing remains an important component of Maine's fishing diversity and heritage in the Gulf of Maine. Current fisheries management impacts the timing and where ground fishing can occur but catch allocation by species is the deciding factor for fishing activity.

Groundfish closed areas are present in the Gulf of Maine and may either be year-round, seasonal, or gear restricted areas. Areas that have been designated as groundfish closed areas have been chosen due to presence of essential groundfish habitat, juvenile nursery grounds, and/or presence of adult spawning aggregations.

There are two year-round groundfish closed areas in the Gulf of Maine, both directly impact Maine fisheries: Cashes Ledge and Western Gulf of Maine (WGOM). There are also five seasonal cod protection closures, two of which have boundaries adjacent to the Maine coastline and extend to the south and east of WGOM from May 1 through June 30, annually.

Overlapping management designations occur within the WGOM groundfish closure, namely the designation of WGOM as an essential fish habitat (EFH) area. Areas denoted as EFH indicate areas of particular importance for the growth and reproduction of fish species. Additionally, the lower half of the WGOM has been designated as a dedicated habitat research area (DHRA). This designation went into effect in 2018 with the implementation of the Omnibus Habitat Amendment 2, that also created the above mentioned HMAs, to site areas of habitat interest specifically for conducting research related to benthic habitat in dynamic environments. (NOAA website 2020).

Unlike lobster, groundfish activity is extensively documented through Vessel Monitoring System (VMS activity)publicly available through the NEODP. These mapping products provide the spatial footprint of this fishery, but do not indicate the species composition, importance of particular species, seasonal distribution, influence of management measures on fishing activity,

or economic importance of particular species. Interviews for this sector provided the context needed to better inform and confirm the VMS characterization.

Fishing permits are allocated a portion of the overall catch based historical participation. Allocations are for specific species with significant sanctions for overages. Regions within the Gulf of Maine can have catch that is predominantly a signal species or can have a mixture catch. Depending on catch allocation, fishermen target specific species. If a mistake is made, and a large portion of the years' allocation for a particular species is caught then fishing for remaining species is limited. There is an ability to lease additional quota of each species, in extreme cases the lease value can exceed the landed value.

Traditional patterns of fishing activity have been superseded by allocation decisions (when and where to fish based on quota allocation. Historically eastern portions of the GOM (east of Cashes Ledge) were targeted in the Spring and Summer based largely around weather being unfavorable in the fall and winter. As Fall progressed offshore fishing activity would move east and by November it was not unusual for much of the GOM fleet to fishing the deep water of Wilkinson Basin.

Wilkinson Basin is a significant fishing area for Maine based boats of all sizes and for all groundfish activity in the Gulf of Maine. Wilkinson Basin is described as having a good mixture of fish which is an important consideration in when considering allocations of individual species. In that this area you are less likely to get a large amount of a single species that can tip the balance of the available quota and limit subsequent fishing.

An area of significant groundfish activity was identified as the 'Wilkinson tow'. The highest fishing intensity abuts the eastern side of the Western Gulf of Maine groundfish closure. The tow begins in the Large AOI and extends south and east out of the area. This tow was described to be important to Maine, New Hampshire, and Massachusetts vessels of all sizes. The location of the 'Wilkinson tow' significantly impacts where fixed gear fishermen set gear, including trap and gillnet.

Maine Gillnet activity was described to target mostly Platts Bank, but activity is concentrated above the 80-fathom edge to avoid conflict with draggers. The areas further inshore, including the Sagadahoc, Mistaken Ground, and Cusk Ridge, that historically provided more gillnet opportunity were described to have been taken over by dogfish and therefore avoided.

Scallop

Scallop fishing in federal waters of the Gulf of Maine is limited to distinct banks that are favorable scallop habitat. Maine vessels are largely restricted to the Northern Gulf of Maine management area, that include Platts Bank, Jeffreys Ledge and Stellwagen Bank fishing areas. Additional important fishing grounds cover the outer portions of Cape Cod and along the northern edge of George's Bank.

Atlantic Herring

Herring is caught using purse-seine and midwater trawling within the area. Herring fishing activity is captured by VMS activity. Fishing intensity was interpreted from the 2015-2016 period from NEODP VMS maps to represent Atlantic herring activity. Herring fishing tends to be on the perimeter of the RFI area, while squid occurs more in Wilkinson and Jordan Basins

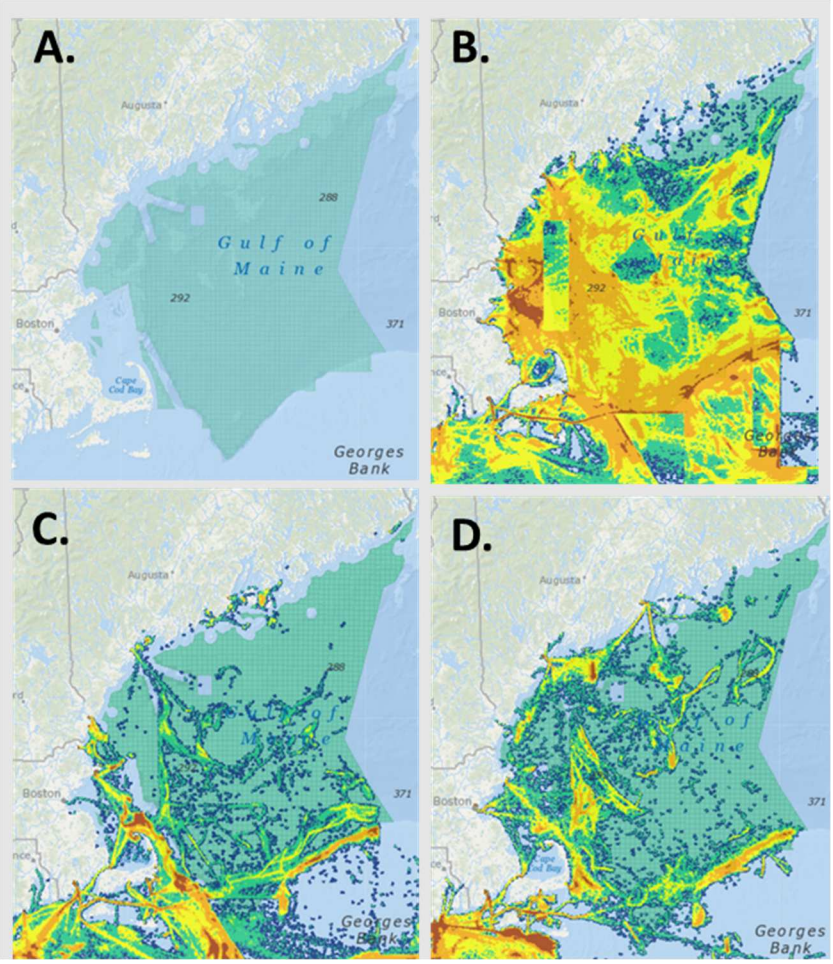

Figure 1. The Gulf of Maine with respect (A) to the RFI; (B) groundfishing VMS activity (2011-14); (C) Scallops VMS 2015-16; and (D) pelagic VMS 2015-16 (herring, squid, mackerel). Source www.northeastoceandata.org

E. Navigation and Safety (as it relates to commercial fishing activity)

Commercial fishing is a significant part of Maine's coastal economy, and the scale of commercial activity from Maine's fishing vessels dwarfs activity and revenue generated elsewhere in the Gulf of Maine. In 2021, state and federally licensed commercial fishermen made 392,000 trips, most of which were made by Maine's approximately 4,675 lobster license holders, 1,260 of whom hold federal permits. As indicated above, lobstering dominates Maine's commercial fishing industry, occurs across Maine's entire coastlines and accounts for most

fishing trips in Maine. Stonington, Friendship, and Vinalhaven are three of the biggest ports for lobster. Additionally, landings reports from lobster fishing do not accurately represent all time spent on the water, as these reports are not representative of days spent setting gear, or days spent fishing without landings. The number of Maine lobstermen fishing offshore has increased in recent years. As discussed in earlier sections, other fisheries such as groundfish, scallop, tuna and others have varied activity in both state and federal waters across the Gulf of Maine during different times of year, resulting in varied and extensive vessel traffic throughout the year.

Unless avoided and mitigated, wind farms and transmission cables may create safety and navigation hazards either through radar interference, or potential risk of towed gear getting caught on cables that are insufficiently buried and the location of any wind farm has the potential to impact fishing vessel navigation. Wind farms may also obstruct traditional transit routes, requiring fishermen to adjust their routes and/or steam further to their fishing grounds. Given the unique navigation and safety issues wind farms may pose to commercial fishing, the Maine Offshore Wind Roadmap's Fisheries Working Group developed several recommendations related to navigation and safety.

Climate Change

The Gulf of Maine is one of the fastest warming regions due to climate change and this change is having measurable impacts on long-established circulation patterns, water salinity and temperature, and marine species ranging from lobsters to right whales. For example, right whales are foraging in the Gulf of St. Lawrence instead of traditional foraging grounds in the Bay of Funday, and Maine's commercial northern shrimp fishery was closed in 2013 after the fishery collapsed following a Gulf of Maine heatwave in 2012. Areas of current habitat importance will likely shift as water temperature and salinity continue to cause a cascade of changes in species distribution due to habitat preferences, areas of primary and secondary productivity,[27] and resulting areas of species foraging aggregations.

How the addition of wind farms may further impact species distributions, commercial and recreational fisheries or other impacts is not yet known. For example, if a lease approved 30 years ago had resulted in fisheries mitigation for the lobster fishery at that time, the associated compensation would have missed a fourfold increase in the population and subsequent fishery resulting in significant economic shortfall to the lobster fishery. Maine's Climate Council was established in 2019 and *Maine Won't Wait,* a four-year climate strategy to combat climate change and protect vulnerable ecosystems was completed in December 2020[39]. Two reports completed for the Maine Climate Council by their Science and Technical Committee (STS) outline Maine's priority coastal and marine monitoring, and research and information dissemination needs. We encourage BOEM to review the "*Scientific Assessment of Climate Change and its Effects in Maine",* and the "*Maine Climate Science Update 2021: An Interim Communication of the Maine Climate Council's Scientific and Technical Subcommittee"* to consider how climate change is impacting the Gulf of Maine and how the siting of wind farms

[39] https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/MaineClimateScienceUpdate2021.pdf

may further impact fisheries and species distributions. Both reports are available at: https://climatecouncil.maine.gov/reports.

Community and Socio-Economic Information related to Maine's Seafood Sector

The Maine coastline spans 3500 miles, roughly the rest of the entire eastern seaboard combined, and its living marine resources largely support the coastal economy. NOAA's Economics: National Ocean Watch (ENOW) Explorer[40] estimated the gross domestic product (GDP) contributed to the State by the marine economy in 2019 to be 5% of total state GDP, at $3.5B. This aligns with the State's estimate of economic impact, given that the ex-vessel revenues alone that year were $664 million, and rose to $890 million in 2021.

The ENOW Explorer also identified that 9% of Maine's total employment was based on the marine economy in 2019, but the State finds this to be a substantial underestimate of the true impact of its seafood industry on the State's economy, and in particular, on the midcoast and downeast regions. ENOW estimates approximately 3500 jobs in the living marine resource sector, including commercial fishing, aquaculture, and wholesale/processing sectors. However, the Maine Department of Marine Resources licenses nearly 400 wholesale dealers and processors at the organizational/corporate level, and close to 10,000 individuals in the commercial fishing and aquaculture sector. This number does not include the many thousands of unlicensed employees of these businesses and fishing operations, nor does it include the thousands of related businesses, including boatbuilding, marine and fishing supplies, and trucking companies that are a critical part of the seafood supply chain. With over 4200 active license holders in the lobster fishery alone, the lobster fishery requires the owner to be on board the vessel during harvesting operations and may employ up to four additional crew per vessel. A recent report by the Island Institute assessing the importance of the lobster fishery to the coastal economy in Maine estimated that the fishery directly employs 8000-10,000 individuals. Additionally, a recent report of economic activity in the Maine aquaculture sector[41] estimated direct and indirect jobs in that sector alone to be 1078 part- and full-time positions.

The ex-vessel revenue of Maine's living marine resources has been increasing steadily in recent years, with its highest year ever on record in 2021 at $890 million. In large part, the record values have been due to the strong landings and value of the lobster fishery. In the last several years, American lobster has been the highest value single species fishery in the nation, and Maine has landed approximately 80% of that product each year. Revenues from Maine's lobster fishery at the first point of sale have ranged between $400-730 million annually in the last seven years. This revenue has become an increasingly significant portion of the overall revenues from living marine resources landed in Maine; in 2021, lobster represented 82% of total revenue from all marine species landed in Maine.

In addition to the economic impact of the lobster fishery, its cultural importance to the coast of Maine cannot be overstated. Maine's coastal population is approximately one third of the total state population, many in rural areas. In addition to many long peninsulas with limited

[40] https://coast.noaa.gov/digitalcoast/data/enow.html.
[41] https://cpb-us-w2.wpmucdn.com/wpsites.maine.edu/dist/1/43/files/2017/01/Aquaculture-Econ-Report-25i1qf3.pdf, p. 2.

commercial activity, there are 15 unbridged islands that host year-round populations. 71% of the 105 coastal communities have fewer than 2500 residents, and 18% have fewer than 500 residents. One does not think about Maine without thinking about Maine lobster, as it is the cornerstone of the state's identity. There are many families on the coast of Maine containing 5th, 6th, or even 7th generation fishermen. Many license holders continue to purchase and hold their licenses long after the time where they may actively fish, because the possession of the license is central to their identity as a lobsterman. The licensing system is designed to support access to the fishery for young people growing up on the coast of Maine, to ensure that future generations can pursue the livelihood. In many coastal communities, the lobster fishery provides one of the few sources of employment. On many of the islands, particularly in the midcoast region, 15-30% of the population holds a lobster license, and a much greater percentage of the community is supported on the income generated by those license holders. As NOAA Fisheries acknowledged in the Final Environmental Impact Statement, Regulatory Impact Review, and Final Regulatory Flexibility Analysis for Amending the Atlantic Large Whale Take Reduction Plan: Risk Reduction Rule (June 2021) (FEIS), counties in midcoast and downeast Maine, where the lobster fishery is the major driver of the commercial fishing economy, are the most vulnerable to adverse social impacts from actions that could constrain the fishery. These counties are highly dependent on fishing, and the high poverty and unemployment rates in these counties suggest that they have limited capacity to absorb additional economic stress.[42]

The scope of effort in this fishery is significantly greater than that of any other state or fishery on the eastern seaboard. Maine has approximately 1260 federal lobster permit holders operating inside this line, who make approximately 260,000 trips annually. By way of comparison, all other federal permits combined (including vessels from Maine to North Carolina) operating in Gulf of Maine (inside and outside of this line) total 929 permits making 42,000 trips annually. Lobster landings vary by region and as a function of distance from shore. For the period of 2015-2020 landings from shore to three nautical miles represented 70%; from three to twelve miles 20%; and from twelve to the Lobster Management Area 1 border 10%. Should the lobster fishery become constrained, Maine's heavy dependence on this fishery puts the coastal economy in great peril. Although even the cumulative value of all other fisheries and aquaculture species would not be able to compensate for the loss of a substantial portion of the lobster fishery's ex-vessel revenues, the diversification options that remain are increasingly important to maintain. Preserving diversification opportunities is one of the highest priorities for the Maine Department of Marine Resources, and this priority has only become more critical as the lobster fishery faces additional significant regulatory action to protect North Atlantic right whales.

Culminative Impacts

Explicit cumulative impact assessment should be considered, including how effects of activities interact, rather than simply considering a list of single stressors on their own which has been shown to underestimate the overall effects of multiple concurrent activities[43]. Additionally,

[42] https://www.greateratlantic.fisheries.noaa.gov/public/nema/apsd/2021FEIS_Volume%20I.pdf, p. 291.
[43] https://doi.org/10.1890/ES13-00181.1

the heterogeneous distribution of many resources and ocean characteristics means that the placement of wind farms can determine the extent of cumulative impacts they may have. Local impacts will differ between specific locations, and this will shift how these impacts are translated to the larger ecosystem[44]. Similarly, indirect effects of turbines should be considered which would include evaluating impacts on areas outside of the lease areas. Because populations of most species are not restricted to defined areas, measuring the impact of turbines on individuals within a lease area may over or underestimate the effects by only looking at a small part of that population. Overall, the connectivity of a potential lease area to the rest of the ecosystem should be considered to get a fuller picture of potential effects of installing turbines in that area.

It should be noted that large data gaps exist on resources and activities in the Gulf of Maine. When analyzing species, community, or ecosystem responses to OSW data gaps should be taken into consideration so that a lack of effect is actual and not a byproduct of a lack of data. This is true of some fisheries as well where data on use of some areas and catch and effort is lacking.

[44] https://doi.org/10.1016/j.scitotenv.2020.139024